



SPREADING KNOWLEDGE BEYOND THE CLASSES: ADAPTIVE E-LEARNING USING SEMANTIC WEB TECHNOLOGY

Juhi Agarwal¹, KamalPreet Singh²

Assistant Professor, University of Petroleum and Energy Studies, Dehradun

Abstract

An adaptive e-learning system provides specific learning content to the specific learner according to their knowledge level, preferences, Prerequisite knowledge and learning style. Individualization is very important to improve learning experiences. The aim of e-learning is to improve the learner's learning and performance levels during online learning. Each student may have different learning styles, preferences and knowledge levels. This is the reason why there is the need for adaptability of learning environment. The adaptive intelligent system helps students to achieve their learning goals effectively. So, there is an aim to provide education to students or learners in different places around the whole world at any time, where no teacher is available for face-to-face help. In this, Semantic Web technologies can also used to have changed the direction of E-learning systems from task-based approaches to knowledge-intensive ones. Semantic web overcome limitations of the current web. In this paper we have suggested new strategies for constructing Adapting system in e-learning using the semantic web where we can search the content according to individual learner. In paper we have proposed architecture, data flow diagram and algorithms to fulfill the individual needs. Using semantic search, it can improve the process of searching .It analyzes the learners model with the help of ontology. After the implementation of this e-learning system, the learner will get a new positive educational experience.

Keywords: Adaptive learning, semantic web, e-Learning.

I. INTRODUCTION

Adaptability is the main issues in today's online e-learning era. The e-learning systems provide educational services to a wide range of students and they can help students to achieve their learning goals by delivering knowledge in personalized way [1]. The adaptability involves identifying and monitoring the student's learning activities according to his respective profile. So, there is an aim to provide education to students or learners in different places around the whole world at any time, where no teacher is available for face-to-face help. This is one of the reasons why to support e-learning systems. It would provide individualized help just as human tutor does. [2].In this, Semantic Web technologies can also used to have change the direction of E-learning systems from task-based approaches to knowledge-intensive ones. Semantic web overcome limitations of the current web. It supports the implementation of intelligent agents, provides features of adaptability, using search engines and inference. [3][4][5]. In this paper we have suggested new strategies for constructing Adapting system in e-learning using the semantic web where we can search the content according to individual learner. In paper we have proposed architecture, data flow diagram and algorithms to fulfill the individual needs. The paper represents two main algorithms which other paper lacks. The proposed first algorithm is for presenting the user the tutorials for the requested topic by checking if the user is eligible for that tutorial. The second algorithm is for showing the user the tutorials in a style best suited for him i.e. by checking his preferences, his learning style, his preferred language etc. After the implementation of this

e-learning system, the learner will get a new positive educational experience.

II. RELATED WORK

Adaptive systems are capable of adapting the content according to the profile of a particular learner. Thus, using adaptive learning learners with different learning goals, knowledge, preferences, knowledge level and learning styles can access different contents/data with different presentation formats. In order to ensure that information to be learnt more accurately, the content presented in systematic way. Semantic web technology organizes knowledge in more structure and more meaningful way. The most common adaptive learning systems consists of ontology whose major function is to provide a domain ontology and user ontology in order to provide adaptive support. In [6] paper discusses about some fundamental

Semantic Web technologies and applications of these technologies in e-learning but it does not explain the any algorithm for practically understand the concept. The work described in [7] utilizes semantic web with personalization web service and related work is done in [8] and [9]. In [10] only the learners' behavior is explained, paper is not giving any algorithm to practically implement the methods. In [11] only architecture and learning environment is explained. So the traditional methods and papers neither were providing accuracy nor effective methods and algorithm to dynamically collect the data according to individual learners. Therefore, in this paper, we have adopted the architecture, algorithm and work flow diagram as one the well known source of information for personalization.

III. PROPOSED METHOD FOR ADAPTIVE SYSTEM BASED ON SEMANTIC WEB

A. Architecture of proposed Adaptive System

Personalized system provides the content according to individual learner means according to each learner's level of knowledge, preferences, and other considerations. Here we have proposed an adaptive learning system which is based on semantic web technology that can provide highly personalized learning content. The architecture of the proposed adaptive learning system is shown in Figure1.

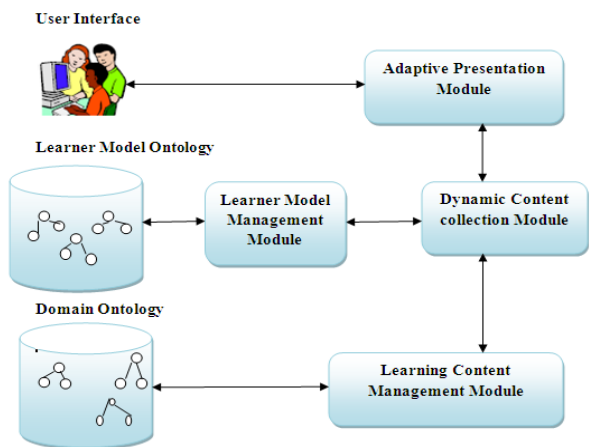


Figure 1: Architecture of the proposed ontology-based adaptive learning system

Ontology is used in knowledge-based systems as conceptual frameworks for providing, accessing, and structuring information in comprehensive manner. The ontology contains nodes, edges and relationship between them. We have constructed the ontology using the tool Neo4j.

1) Domain Ontology: Domain Ontology is a representation of domain knowledge which is known as domain Ontology. It describes the complete structure of domain. It is information content of the application which contains the concepts and concept relationships. The domain model of the system is totally based on the notion of learning aim.

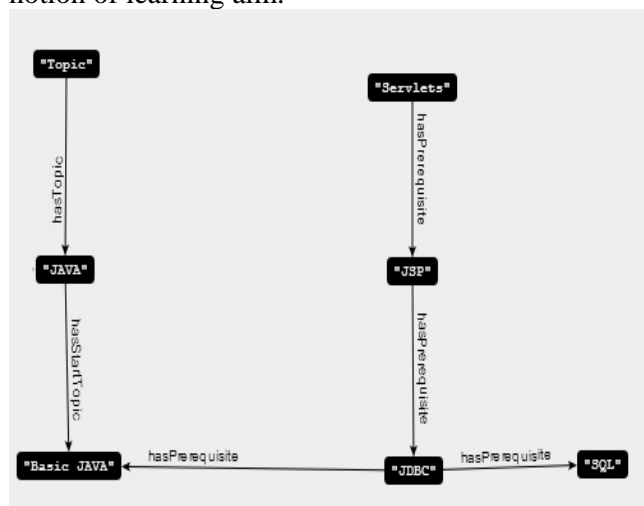


Figure 2: Domain Ontology.

As it is shown in Figure 2, there is a central node named Topic connected to the node JAVA with the hasTopic relation which is further connected to the subtopics by the hasStartTopic relation in the domain. The Ontology is explained as further

- The Topic node is the central node which connects to the tutorials which are present in the

system by connecting it to subject nodes by hasTopic relation. There can be several nodes connected to the Topic node which would be the topics of which the tutorials would be present in the system.

- Here JAVA node is presenting a subject in whole which can be chosen by the learner or student. The subject nodes (like JAVA) are connected to the starting subtopic from which a learner should start its learning of that subject/topic.
- Further each subtopic presented as a node is connected to each other through hasPrerequisite relation forming a relation among these nodes which indicates the dependent topics a learner should know and have cleared with proper marks before she can take the tutorial of the next or desired subtopic in a subject/topic. The connected graph of subtopics is also known as *Prerequisite Graph* which shows the prerequisite subtopic of every subtopic by forming a relation between them.

As you can see that *SQL* node not being a part *JAVA* language has been shown as the prerequisite of the *JDBC*. This has been shown to clearly demonstrate that *SQL* is the prerequisite of *Java Database Connectivity (JDBC)* subtopic, which give the learner an opportunity to understand more clearly the dependence between different subjects (*SQL* node can be subtopic of *DBMS* tutorial)

2) *Learning content management module*: It is responsible for managing the content of knowledge base or Domain ontology. It inserts, deletes a new learning data into the domain

Ontology or manipulates existing learning objects.

3) *Learner model Ontology*: This Ontology stores all learner-related data, i.e. the learner's profiles, including the behavior, characteristics, knowledge level, history, prerequisite knowledge, performance and deficiency record. In Figure 3, the Learner Model Ontology has been shown. Here the learner *Vishesh* has chosen to learn *JAVA*. He is currently learning *JDBC* topic. The model explains this as follow:

- The user is represented as a node in the model.
- The node representing the subject that the user chooses to study is connected by *hasChosen* relation to the node representing that user. This *hasChosen* relation shows the subjects that user opts to learn.
- The subtopic of subject which the user is currently studying are shown by a relation between the user and that subtopic node by *isLearning* relation.
- Thus the user should have completed all the prerequisite subtopics connected to the subtopic the user is currently learning to have a healthy learning process.
- All the user details and information are stored in the user node as properties and values. For example, the language preference of the user, the rank.

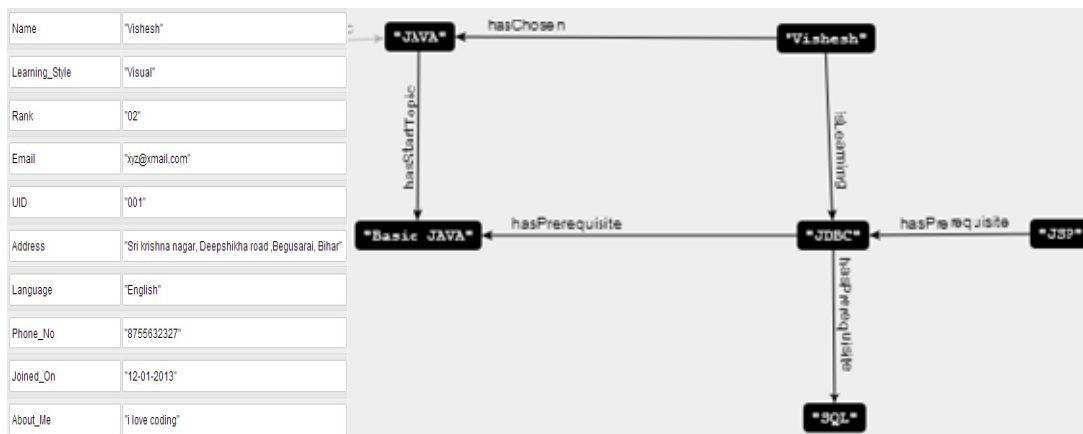


Figure 3: Classes, Object Properties and Data Properties of the Learner model Ontology

- 4) *Learner Model Management Module*: It updates any changes in learner model ontology like updates data of history, performance and deficiency record.
- 5) *Dynamic Content Collection Module*: This module dynamically generates personalized learning content for a specific learner. This module is totally capable to combine available content (obtained from Learning Content Management Module) to form a coherent learning content that suits a particular learner.
- 6) *Adaptive Presentation Module*: The adaptive presentation module is responsible for presenting individualized learning content to the learner based on results from the dynamic content collection module. It presents adaptive e-learning content to the learner using link-hiding techniques. It hides the entire advance topic from the user and only shows the current content or previous covered content of the same topic. Green bullet shows a recommended content means the concept that the learner has not learned yet, but has knowledge about all previous topics. Yellow bullet shows the topic which is covered topic.
- 7) *User Interface*: It provides the interaction between the system and the learner.

B. Workflow of Adaptive System

Under the proposed architecture, the adaptive system allows learners to get specific information about the learning content for the specific learner.

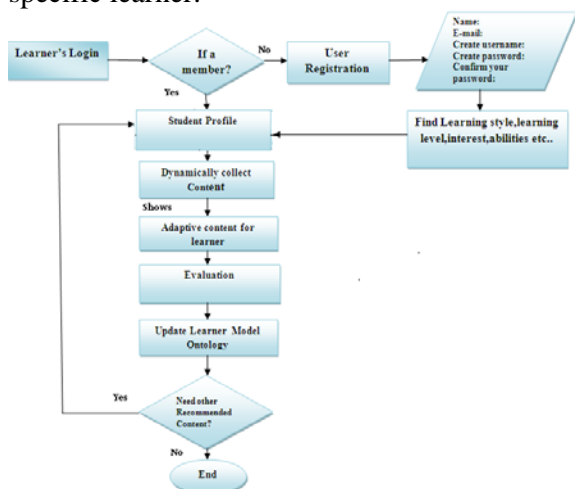


Figure 4: A Description Scenario of the workflow of Adaptive e-learning system.

A Scenario Example: Tom is a user. He registers himself on the website by filling up information about himself like his preferred learning style, language, email address, phone number etc. A node is created for the user containing all this information as properties. The user has to begin with some topic, so he searches for the available topics. He chooses JAVA and start reading its tutorials. When he selects a topic in which he is interested, the system looks for its prerequisites and if those subtopics which are its prerequisites are completed by Tom, only then can he start reading this tutorial. The use node is then connected to the topic that he has selected with *hasChosen* relation. Tom is presented with the tutorials of the selected topic. Once he completes reading these tutorials, the system evaluates him by presenting him questions related to the topic. He is allowed to go to next topic in the hierarchy only if he passes the test. The system sees overall performance of the users of the system and allocates a rank to each user based on their performance. The result of the user for the exam for individual topics is stored as a property in each individual node. The system collects content from the database, checks his preferences and the content is presented to the user according to his preferred learning style, language, his learning goal and how he has performed in the previous tests. There are basically four types of learning style. The each learning style is explained in the table given below:

TABLE I: Different Learning style dimensions

Visual	Pictures & Demonstrations
Verbal	Words & Explanation
Sensing	Patient with details, Careful but may be slow, Senses, facts and experimentation.
Intuitive	Quick but may be careless, principles and theories.
Sequential	Steady progression and Convergent thinking and analysis.
Global	Jumping directly and Divergent thinking.
Inductive	ability to figure out the Rules/theories/principle from observed instances of an event.
Deductive	Moving from specific observations to broader generalizations and theories.



Figure 5: screenshot for determining students learning style.

A set of questions are asked to the user when he registers on the website. The answer of each question selected by the user is stored as a property-value set in the user node in user domain.

IV. PROPOSED ALGORITHM

The proposed first algorithm is for presenting the user the tutorials for the requested topic by checking if the user is eligible for that tutorial. The second algorithm is for showing the user the tutorials in a style best suited for him.

A. Algorithm to show the user chosen tutorial according to user preferences
startTutorial(): This function checks the eligibility of the user for reading his chosen tutorial. The boolean variable `eligible` stores true or false. If `eligible` is true, it means the user is eligible for the tutorials for his chosen topic. When a user selects a topic, a list of its subtopics is presented to him, when he selects a subtopic, the prerequisites for that subtopic are searched. The system checks whether the user has cleared all the prerequisites. If any of the prerequisites is not cleared, `eligible` becomes false and the system presents to the user those subtopics which user has to clear first. The user is given option to directly take its test and clear the level or to read the tutorials first.

showTutorial(subTopic): This function shows the user the tutorials according to the preferences of the user. The content is presented to the user in the user in the form best suited for him i.e. his preferred language, according to his learning style etc. After the tutorial is over, the user is presented with the questions. If the user

passes the test i.e. if he gets more marks than the cut off, he is advanced to next level and the new subtopics available for the user are shown. If the user fails in test, he is given choice to re-read the tutorials or re-take the test.

```

1. startTutorial()
2. {   boolean eligible ← true;           //whether
      user is eligible to get selected tutorial?
3.   topic ← getUserSelectedTopic() //gets
      user's chosen topic eg. JAVA
4.   showSubTopics(topic); //show the
      subtopics of the selected topic to user
5.   subTopic ← getUserChoice(); // gets
      user's chosen subtopic eg. JDBC
6.   prerequisites[] ←
      getPrerequisites(subTopic); // gets all
      the prerequisite topics of the selected
      subtopic. In case of JDBC, prerequisites are
      SQL and Basic Java
7.   for each st in prerequisites[]
8.   {   if(! hasUserCleared(st))
9.       then
10.          eligible ← false; //The
          user is not eligible for his selected tutorial
          as he has not cleared the prerequisites
11.   }
12.   if(eligible)
13.   then
14.       //connect user node to the selected
          subTopic node with isLearning relation
15.       showTutorial(subTopic);
16.   else //Show all the prerequisites which
          are not cleared by the user
17. //Give the user the choice to read tutorial or
      di | }

```

B. Algorithm to show the user chosen tutorial according to user preferences

```

1. showTutorial(subTopic)
2. {   getUserPreferences(); //get user preferences
      from the database
3.   //present the tutorials according to the user
      preferences, in users chosen language,
      learning style. Eg. if user's chosen learning
      style is visual, the system would present
4.   result ← takeTest(); //after user finishes
      tutorial, user is presented with questions
5.   storeInDatabase(result); //result is stored in
      the subTopic node as a property-value set
6.   if(result > cutoff)
7.   Then
8. //show the user the list of available subtopics of
      next level based on user choice, show next
      tutorial
9.   else
          //give the user the choice to re-take
          test or re-read tutorial
      }

```

V. CONCLUSION

In this paper considerable efforts have been made in the adaptive learning using semantic web searching to standardize knowledge learning building blocks. Adaptive system in e-learning presents the data according to the learner's knowledge level, preferences, Prerequisite knowledge and learning style. This paper attempts to respond to the demand for self-adaptive learning systems by providing an architecture, algorithm and data flow diagram. The suggested algorithm is guiding learners towards a customized learning route. The implementation of the presented Adapting system in e-learning environment framework further provides an open learning environment to offer enriching learning experiences.

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